Government

A vision of smarter cities

How cities can lead the way into a prosperous and sustainable future

IBM Institute for Business Value

IBM Global Business Services, through the IBM Institute for Business Value, develops fact-based strategic insights for senior business executives around critical industry-specific and cross-industry issues. This executive brief is based on an in-depth study by the Institute's research team. It is part of an ongoing commitment by IBM Global Business Services to provide analysis and viewpoints that help companies realize business value. You may contact the authors or send an e-mail to iibv@us.ibm.com for more information.

IBM

A vision of smarter cities

How cities can lead the way into a prosperous and sustainable future

By Susanne Dirks and Mary Keeling

An urbanizing world means cities are gaining greater control over their development, economically and politically. Cities are also being empowered technologically, as the core systems on which they are based become instrumented and interconnected, enabling new levels of intelligence. In parallel, cities face a range of challenges and threats to their sustainability – across their business and people systems and core infrastructures such as transport, water, energy and communication – that they need to address holistically. To seize opportunities and build sustainable prosperity, cities need to become "smarter."

A century ago, fewer than 20 cities around the world had populations in excess of 1 million people.[1] Today, that number has swelled to 450 and will continue to grow for the foreseeable future.[2]

As cities grow in both numbers and population, they are taking their place on the world's center stage, with more economic, political and technological power than ever before. Economically, they are becoming the hubs of a globally integrated, services-based society.

Politically, they are in the midst of a realignment of power – with greater influence, but also greater responsibility. From a technology standpoint, advances are underway that can provide them with better understanding and control of their operations and development.

Operationally, cities are based on six core systems composed of different networks, infrastructures and environments related to their key functions: people, business, transport, communication, water and energy. A city's

people system includes public safety, health and education and is central to whether it delivers a good quality of life for its citizens. A city's *business* system refers to the environment that businesses face in terms of policy and regulation. Cities offer people and business the ability to move things around through their *transport* systems and to share ideas and information through their *communication* systems. Cities also offer two core utilities necessary for all economic and social activity – *water* and *energy*.

These systems are not discrete, however. They interconnect in a synergistic fashion that, ideally, promotes optimum performance and efficiency. The six core systems, in effect, become a "system of systems."

However, while providing the potential for significant positive transformation, each element of this "system of systems" faces significant sustainability challenges and threats. For example, cities face considerable healthcare issues, such as infant mortality and the worldwide HIV pandemic. For businesses, cities must balance regulatory requirements with the need to decrease costly administrative overhead. Inefficient transportation systems continue to drive up costs. Increasing communications and connectivity demands challenge the ability of cities to meet the needs of its citizens and businesses. Water resources fall victim to leakage, theft and poor quality. And current energy systems are often insecure and inefficient.

As cities face these substantial and inter-related challenges, it becomes clear that the *status quo* – business as usual – is no longer a viable option. Cities must use their new power to become *smarter*. They must act now, using new technologies to transform their core systems to optimize the use of limited resources.

The opportunity presented by smarter cities is the opportunity of sustainable prosperity. Pervasive new technologies provide a much greater scope for instrumentation, interconnection and intelligence of a city's core systems. Around the world, leading cities are putting in place smarter systems, such as Galway's *SmartBay* advanced water management system, Songdo's *Wired City* initiative or Singapore's *eSymphony* transport system.

Becoming a "smarter city" is a journey, though, not an overnight transformation. Cities must prepare for change that will be revolutionary, rather than evolutionary, as they put in place next-generation systems that work in entirely new ways. City administrations must decide what activities are core, and, therefore, what they should shed, retain or expand into. Not only that, cities must "assemble the team" – integrate their own administrations and work with other levels of government, especially country-level, as well as private and non-profit sectors. Cities must also take into account the interrelationships among the systems they are based on, as well as the interactions among the challenges they face.

A vision of smarter cities

How cities can lead the way into a prosperous and sustainable future

Power and responsibility as cities take center stage

In 2008, for the first time in human history, the majority of the world's people lived in cities.[3] And cities for the foreseeable future will continue to grow faster than the countrysides surrounding them (see Figure 1). Globally, the number of people living in cities of 1 million or more will grow from about half a billion in 1975 to almost 2 billion in 2025.[4] As a result, cities have assumed a central role in the urbanized world of the 21st century. They are wielding more economic power, developing greater political influence and increasingly employing more advanced technological capabilities to enhance their operations.

FIGURE 1.

Percentage of total population living in cities, 1990-2050(forecast).

Legend:
- 1990
- 2020 Forecast
- 2050 Forecast

Developed countries: 73%, 80%, 88%
Developing countries: 35%, 51%, 67%
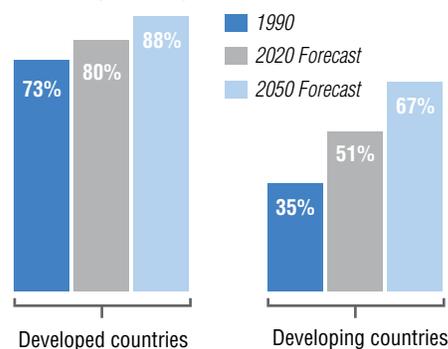
Source: IBM Institute for Business Value analysis of United Nations data.

The world economy is now globally integrated and services-based, with cities as its hubs

The nature of commerce has transformed appreciably since 1990, with global trade now accounting for two-thirds of all output, compared to only one-third 20 years ago.[5] In developed economies, service provision has supplanted production as the primary economic activity, accounting for nearly three-quarters of all trade.[6]

A globally integrated, services-based world economy means that business will locate activities where capital – both human and physical – is concentrated, i.e., cities. Three-fifths of businesses list availability of qualified staff (human capital) and quality of telecommunications (physical capital) as absolutely essential.[7] Cities have higher levels of physical and human capital compared to the countries around them. They have higher shares of workforce with tertiary education (see Figure 2) and a stronger capacity for innovation – more than 81 percent of Organization of Economic Cooperation and Development (OECD) patents are produced in urban regions.[8]

Cities are based on
a number of different
systems central to
their operation and
development.

FIGURE 2.
Percentage of workforce with tertiary education, selected cities compared to country average, 2005 or latest.

City	Country	Metro
Prague	14%	28%
Berlin	24%	35%
Indianapolis	27%	35%
Stockholm	29%	36%
Seoul	32%	38%
London	30%	39%
Boston	27%	41%
Oslo	32%	45%
Brussels	35%	46%
Washington	27%	49%
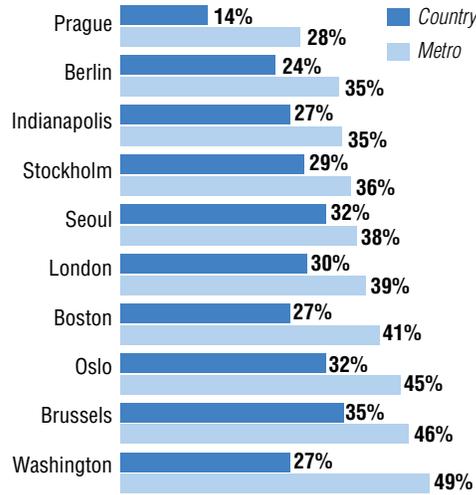
Source: IBM Institute for Business Value analysis of OECD and US Census data.

The political landscape has changed, with cities becoming more important actors

Politically, systems around the world are migrating away from the nation-state model prevalent in the past century. This has led to the emergence of multi-level governance, giving cities greater freedom. New forms of vertical collaboration are emerging among different levels of government. Within metropolitan regions, organizations are choosing a range of levels of cooperation – from informal networks, such as those in Spain's Bilbao and Germany's Rhine-Ruhr, right through to amalgamation of formerly separate urban districts as in Melbourne, Australia, and Montreal, Canada. This has expanded across borders with the growth of international cities such as Basel-Mulhouse-Freiburg (Switzerland, France and Germany) and Copenhagen-Malmo (Denmark and Sweden). Cities are also assuming greater legal and fiscal powers. And more cities now have directly elected mayors, instead of political appointees.

Technological advances mean that cities can better understand and control their operation and development

Technological advances mean that aspects of the operation and development that city managers have previously been unable to measure – and therefore unable to influence – are increasingly being digitized. This instrumentation creates brand new data points about, for example, the efficiency of a city's water or transport systems. In addition to being instrumented, different parts of a city's systems can be interconnected, so that information flows between them. With the greater digitization and interconnection of a city's core systems, the newly gained information can be used for intelligent and informed decision making.

Today's challenges put cities under pressure to act now
Cities are based on six core systems

Cities are based on a number of different systems – infrastructures, networks and environments – central to their operation and development: people, business, transport, communication, water, and energy. The effectiveness and efficiency of these systems determine how a city works and how successful it is at delivering its goals. These systems are not discrete and must be considered holistically, as well as individually.

- *People*: A city's people system refers to its human and social networks. These include public safety (fire, police and disaster recovery), health, education and quality of life.

- *Business*: A city's business system encompasses its regulation and policy environment and includes planning regulations, openness to foreign trade and investment, and labor and product market legislation.

- *Transport*: A city's transport system includes all aspects of its road network, its public transport network and its sea and air ports, from provision to pricing.

- *Communication*: A city's communication system includes its telecommunications infrastructure, including telephony, broadband and wireless. The ability to access and communicate information is central in a modern economy and key to a smarter city.

- *Water*: A city's water system is an essential utility that includes the entire water cycle, water supply and sanitation.

- *Energy*: A city's energy system, as essential as its water resources, includes its power generation and transmission infrastructure, as well as its waste disposal.

These core systems are interconnected and must be treated as such. Understanding one system and making it work better means that cities must comprehend the bigger picture and how the various systems connect.

Cities are being empowered at a time when they face significant *challenges* and *threats to sustainability* in each of the six interrelated systems and must act now to secure future prosperity.

People: From demographic changes to health, cities face major challenges and threats to their sustainability
While on average urban populations are growing, cities in developed countries often face shrinking populations – in the last 30 years, more cities in the developed world shrank than grew.[9] These cities will require new ways to stay globally competitive and attrac-

tive to skilled labor. In developing cities, even though they are growing, the skills challenge is likely to be just as great due to brain drain, the flight of people with skills to areas perceived to offer greater economic opportunity.[10] Cities also face significant healthcare challenges, ranging from infant mortality to the HIV/AIDS pandemic. With growing health challenges, the fiscal sustainability of health systems will be pushed to the limit. In North America, for example, the costs of healthcare are anticipated to increase dramatically – to 20 percent of GDP in the United States and more than half of provincial tax revenues in Canada.[11]

Business: Cities must balance complex regulatory requirements with the need to minimize unnecessary administrative burdens
Cities depend on their business systems for their prosperity. Less efficient administrative systems can cost as much as 6.8 percent of GDP in some economies.[12] A 25-percent reduction in administrative costs – e.g., time spent filling out forms – could yield savings of up to 1.5 percent of GDP, or some €150 billion (approximately US$209 billion).[13] As Figure 3 shows, the number of days it takes to undertake the same process – starting a business – in different cities varies dramatically, even within the same country. With cities becoming more important actors politically and economically, solving the dichotomy between where laws are made and implemented will be central to the efficiency and effectiveness of cities' business systems.

FIGURE 3.
Number of days to start a business, various cities, 2007/2008.

City	Days
Manila	52
Zagreb	40
Beijing	37
Warsaw	31
Guangzhou	28
Tokyo	23
Belgrade	23
Padua	17
Alexandria	15
Dublin	13
Cairo	9
Tirana	8
Washington	6
Copenhagen	6
Ottawa	5
Singapore	4
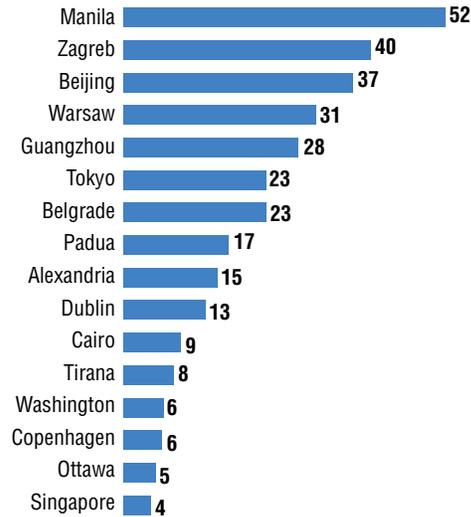
Source: World Bank Doing Business Sub-national reports.

Transport: Inefficient systems will continue to drive up costs without city action

Urbanization and globalization create more commuters and more freight traffic in the world's ports. Traffic congestion cost the U.S. economy US$78 billion in 2005, resulting in 4.2 billion lost hours, as well as pollution and wasted fuel.[14] These costs are growing at 8 percent *per annum*.[15] The economic costs of congestion in New York alone are close to US$4 billion a year.[16] A number of estimates suggest that congestion costs – in developed and developing cities – are between 1 percent and 3 percent of GDP.[17] In emerging market cities, car ownership rates are currently a fraction of the 75-90 percent of OECD countries. As car ownership grows from less than one in ten people to one in three or higher, even greater strain will be placed on the transport infrastructure.

Communication: Cities face challenges in meeting ever-greater demands for connectivity

The last 20 years have seen a revolution in how we communicate and inform ourselves, in particular the ability to share information through the Worldwide Web. However, while the online population has grown by almost 350 percent since 2000, the vast majority of the world's population – 5.1 billion – is still not online and is denied the benefits of tapping into a worldwide network of information (see Figure 4). The speed of connectivity has also become increasingly important. In March 2009, average speeds for those with broadband varied from 4.6 megabits per second in Asia to 1.1 megabits per second in Africa.[18] As the citizens of Tokyo and Yokohama prepare for gigabit-per-second connectivity, city managers must begin planning for a terabit world.[19]

FIGURE 4.
Online versus total population, by continent, 2008.

| Continent	2008 online	2008 population
Asia	657	3780
Africa	54	975
Europe	393	804
Latin America	174	581
North America	251	338
Middle East	46	197
Oceania	20	34
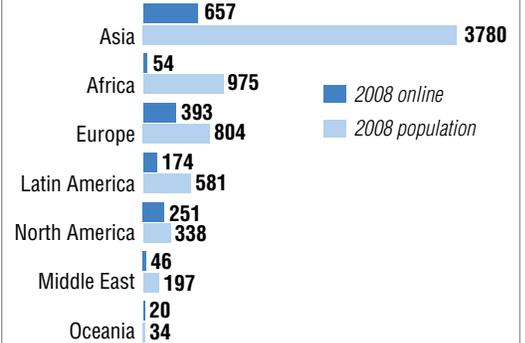
Source: Internetworldstats.com; UNCTAD.

Water: Problems with water efficiency, leakage, quality and the threat of flooding pose a significant threat to cities' sustainability

Water is fundamental for sustaining human life. Every economic exchange involves a virtual exchange of water. As cities grow, so does their thirst for water. Cities today account for 60 percent of all water allocated for domestic human use.[20] However, globally, less than half of water supplies are accounted for (see Figure 5). Leakage rates often represent up to 60 percent of water supplied, costing water utilities worldwide US$14 billion every year.[21]

FIGURE 5.
Usage of global water supplies and estimated costs.

- 47% Water used
- 35% Leakage ($9.3bn)
- 18% Theft/Poor metering ($4.7bn)

Source: World Bank, 2006.
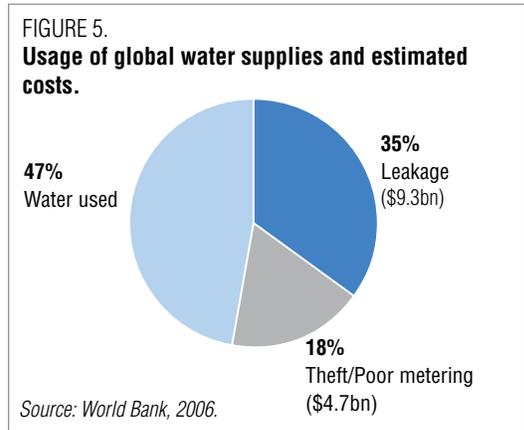
Currently, 2.8 billion people, or 44 percent of the world's population, live in areas of high water stress.[22] Present trends suggest that this will rise to almost 4 billion by 2030 (see Figure 6).[23] Globally, water shortages are estimated to cause an annual loss to economic growth of about 3.6 per cent.[24] In California, the cost of water issues is already 2 percent of the state budget.[25]

FIGURE 6.
Global population in high water stress areas, billions.

- 2009 estimate: 2.8
- 2030 forecast: 4.0
- +39%

Source: World Economic Forum.
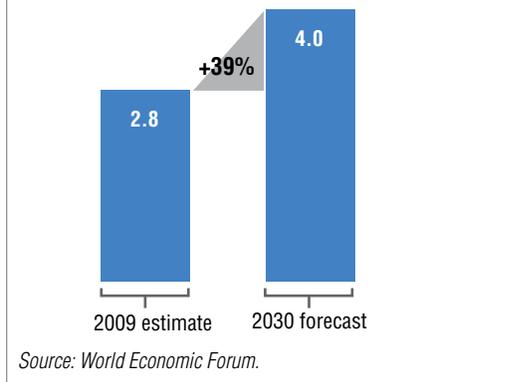
Energy: Cities are realizing current energy systems are insecure, inefficient and unsustainable

Global emissions of CO_2, the principal greenhouse gas, are expected to have increased by more than 45 percent between 1990 and 2010, driven largely by the growth of cities (see Figure 7). Cities generate the vast bulk of CO_2 emissions; therefore reducing their CO_2 emissions is necessary for a healthier planet. As a result, city policymakers are under growing pressure – from citizens and from investors – to incorporate into their policy-making environmental sustainability in general and greenhouse gas emissions in particular. Cities are starting to rise to this threat to their sustainability, with the mayors of 400 European cities, for example, pledging in February 2009 to make "drastic" cuts in CO_2 emissions by 2020.[26]

Providing secure and sustainable energy for their citizens is a key challenge for cities over the coming generation. Globally, almost one in three people lack access to electricity.

And while access to energy is widespread
in more developed cities, it is still not secure.
In the United States, for example, blackout
threats are increasing in the wake of an overall
reduction of baseload energy reserves from 30
percent in the early 1990s to only 17 percent in
2007.[27]

FIGURE 7.

**Global CO$_2$ emissions (metric tons), 1990, 2010
and 2030, urban/non-urban.**
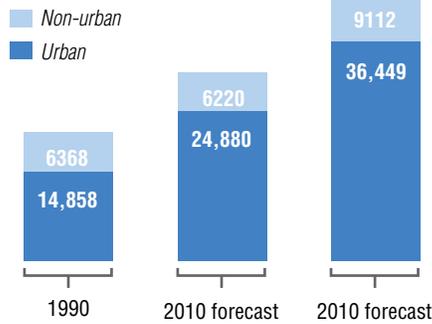
Source: U.S. Energy Information Administration Annual Outlook
2008; IBM Institute for Business Value estimates.

Cities face interconnected challenges

These challenges and threats to sustainability
are not only significant in and of themselves,
they are also interrelated (see Figure 8). For
example, a city's information and *communica-
tion* infrastructure is central to its attractiveness
to business and mobile investment. The
business networks of a city are a key factor
for *transportation* usage, itself a primary
consumer of energy and an emitter of green-
house gases – buildings and transport alone
account for 25 percent of all emissions.[28]
Energy production currently accounts for
between 30 and 40 percent of all *water* with-
drawals in the OECD.[29] Assuming business
as usual, energy-related *water* consumption
will more than double in the next 20 years in
the European Union and the United States.[30]
Water underpins all economic activity – be it
the 2,000 gallons required to make one gallon
of milk or the 39,000 gallons to make a car.[31]

FIGURE 8.

Sample of interrelationships between core city systems.
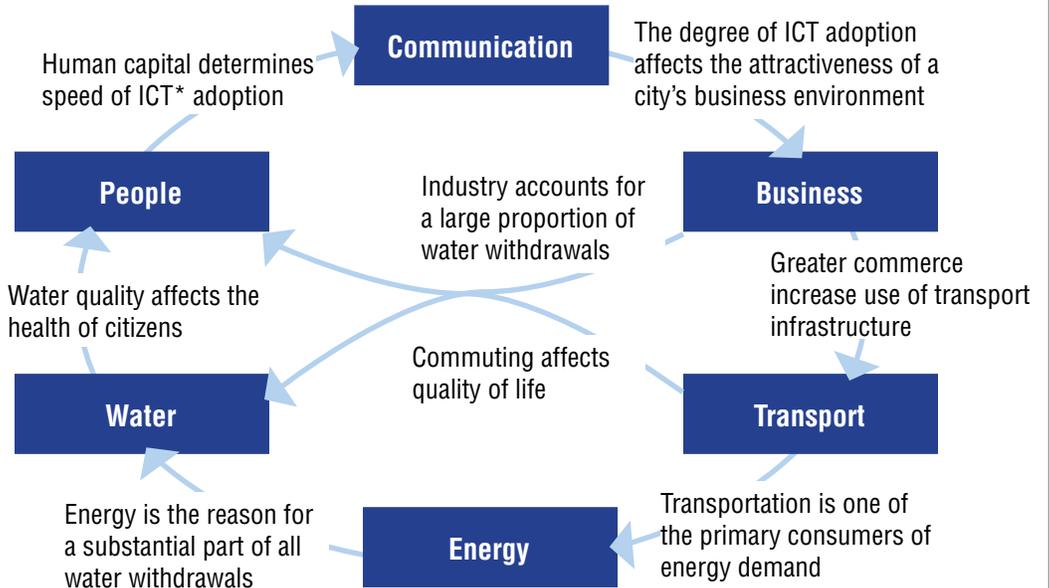
*Note: ICT=Information and communications technology.
Source: IBM Center for Economic Development analysis.

Water is also one of the most important factors for a city's *health*, with water-borne disease affecting hundreds of millions of people around the world. Some of these intricate inter-relationships are outlined in Figure 8.

"Smart" cities know how to transform their systems and optimize use of largely finite resources

The scale and nature of the challenges facing cities across each of their core systems mean that business as usual is not a viable option. Despite these challenges, cities have a range of goals they want to deliver for their citizens. They strive to provide a healthy, pleasant and safe living environment for their residents. They also endeavor to attract business, help it thrive in a competitive global economy, as well as provide an effective and efficient infra-structure in a sustainable way. To deliver the goals they have established, cities must look to the systems on which they are basing their aspirations and make them more efficient and effective, i.e., *smarter*.

Smarter cities make their systems instrumented, interconnected and intelligent

Pervasive information and communication technology means that there is much greater scope for leveraging technology for the benefit of cities:

- *Instrumentation*, or digitization, of a city's system means that the workings of that system are turned into data points and the system is made measurable. By 2010, there is likely to be 1 billion transistors, the building block of the digital age, for every human being.[32]

- *Interconnection* means that different parts of a core system can be joined and "speak" to each other, turning data into information.

- *Intelligence* refers to the ability to use the information created, model patterns of behavior or likely outcomes and translate them into real knowledge, allowing informed actions.

Smarter cities transform their systems and their "system of systems"

A smarter city is one that uses technology to transform its core systems and optimize the return from largely finite resources. By using resources in a smarter way, it will also boost innovation, a key factor underpinning competi-tiveness and economic growth. Investment in smarter systems is also a source of sustain-able employment. It has been estimated that a US$10 billion investment in smarter broadband communication, healthcare and energy systems grid could create almost 1 million jobs in the United States alone.[33] Imagine the possibilities across all the world's cities.

Each of the core systems identified can be made smarter, by taking advantage of the potential to digitize systems and, thereby, enable more informed decision making.

Today…	What if a city could…	Already, cities are…
People • Cities have difficulty using all the information at their disposal • Citizens face limited access to information about their healthcare, education and housing needs.	• Reduce crime and react faster to public safety threats, by analyzing information in realtime? • Use better connections and advanced analytics to interpret vast amounts of data collected to improve health outcomes?	• Putting in place a new public safety system in Chicago, allowing realtime video surveillance and faster more effective response to emergencies • Giving doctors in Copenhagen instant access to patients' health records, achieving the highest satisfaction and lowest error rates in the world.[34]
Transport • Transporting people and goods is dogged by congestion, wasted hours and wasted fuel.	• Eliminate congestion and generate sustainable new revenues, while integrating all transport modes with each other and the wider economy?	• Bringing in a dynamically priced congestion charge for cars to enter Stockholm, reducing inner-city traffic by 25 percent and emissions by 14 percent, while boosting inner-city retail by 6 percent and generating new revenue streams.[35]
Communication • Many cities have yet to provide connectivity for citizens • "Going online" typically means at slow speeds and at a fixed location.	• Connect up all businesses, citizens and systems with universal affordable high-speed connectivity?	• Merging medical, business, residential and government data systems into a so-called ubiquitous city in Songdo, Korea, giving citizens and business a range of new services, from automated recycling to universal smartcards for paying bills and accessing medical records.
Water • Half of all water generated is wasted, while water quality is uncertain.	• Analyze entire water ecosystems, from rivers and reservoirs to the pumps and pipes in our homes? • Give individuals and businesses timely insight into their own water use, raising awareness, locating inefficiencies and decreasing unnecessary demand?	• Monitoring, managing and forecasting water-based challenges, in Galway, Ireland, through an advanced sensor network and realtime data analysis, giving all stakeholders – from scientists to commercial fishing – up-to-date information.
Business • Businesses must deal with unnecessary administrative burdens in some areas, while regulation lags behind in others.	• Impose the highest standards on business activities, while improving business efficiency?	• Boosting public sector productivity, while simplifying processes for business in Dubai through a Single Window System that simplifies and integrates delivery and procedures across a range of almost 100 public services.[36]
Energy • Insecure and unsustainable energy sources.	• Allow consumers to send price signals – and energy – back to the market, smoothing consumption and lowering usage?	• Giving households access to live energy prices and adjust their use accordingly, as in a Seattle-based trial, reducing stress on the grid by up to 15 percent and energy bills by 10 percent on average.[37]

The city as a "system of systems"

It is critical that the interrelationship between a city's core systems is taken into account to make this "system of systems" smarter, too. No system operates in isolation; instead, a web of interconnections exists. For example, transport, business and energy systems are closely inter-related – the transport and business systems are key users of energy. Connecting these systems will deliver even greater efficiencies and address the interrelated, long-term threats to sustainability. The connection between smarter water and energy systems is another example of the linkages that exist between systems. A substantial amount of electricity generated goes toward pumping and treating water. In Malta, for example, a new smart utility system will inform people and business about their use of both energy and water, enabling them to make better decisions about resource consumption.

Becoming "smart" is a journey, not an overnight transformation

Cities have limited resources. To deliver on the range of ambitious goals they have, cities must take account of the interconnected challenges they face and the interrelated systems they influence. This is a journey for cities, not an overnight transformation. But the first step requires a shift in thinking and a break from the past.

This means that city administrations should develop an integrated city-planning framework, based on deciding where their internal expertise lies – in essence identifying a city's core competencies – and bringing in outside expertise where necessary (see Figure 9). This will rarely align to a city's current allocation of tasks, meaning cities must look at which activities to shed, which to retain and

FIGURE 9.
A framework for strategic planning.

	Non-core competency (External specialization)	Core competency (Internal specialization)
Currently have	**What activities do cities currently do that they should shed?** • Outsource to reduce costs and free up resources; Divest non non-strategic interest.	**What are a city's core activities that should be retained?** • Source of competitive advantage • Do they need to be optimized, reorganized, consolidated?
Currently don't have	**In which activities should cities continue to partner for external expertise?** • Necessary alliances to meet critical needs • Continue to partner and develop new alliances.	**What new activities should a city be expanding into?** • New source of sustained advantage • Use of internal assets, relationships and capabilities.

Source: IBM Center for Economic Development analysis.

potentially reorganize, which to partner for, and which new activities to expand into. Structured modeling tools, such as component business modeling, can help city administrations map out the activities in each of their systems and identify where they should retain, expand, shed and partner.[38]

What cities need to do to become smarter

To put in place a plan for transforming into a smarter city, a city needs to do more than just strategize:

- *Assemble the team*: No city is an island. Administrations – at city level and elsewhere – are recognizing the importance of "perpetual collaboration." To deliver the goals a city has set, city administrations will need to work seamlessly across their own organizational boundaries and partner effectively with other levels of government, as well as with the private and non-profit sectors.[39] Many issues that cities face will require significant collaboration among city, state and national levels of government. In addition to formulating new policies themselves, cities must be able to articulate the challenges they face to influence policies made elsewhere.

- *Think revolution, not evolution*: Rising to the challenges and threats to sustainability requires a city to be more than just focused or efficient; it will require the next generation of city to emerge – one based on smarter systems. These systems are interconnected – people and objects can interact in entirely new ways. These systems are instrumented – the exact condition of the system's different parts can be measured. These systems are intelligent – cities can respond to changes quickly and accurately, and get better results by predicting and optimizing for future events.

- *Target all, not just one*: The interrelationships between the various systems mean that while cities obviously must prioritize, "solving one" is not a viable long-term option. The challenges and threats to sustainability come from all angles and require a holistic strategy that addresses all factors and feedback mechanisms.

Conclusion

"The 19th century was a century of empires, the 20th century was a century of nation states. The 21st century will be a century of cities."
– Wellington E. Webb, former Mayor of Denver, Colorado[40]

Ultimately, a city aims to deliver sustainable prosperity for its citizens. Cities stand on the cusp of their century, with new power – and new responsibility – economically, politically and technologically. Across all systems on which cities are based, they are facing significant challenges and threats to their sustainability. Cities must use new technologies to transform their systems into *smarter* systems that optimize the use of finite resources. Many cities around the world are already starting to seize this opportunity. Is yours?

This study was written by the Center for Economic Development, in Dublin, Ireland, which is part of the IBM Institute for Business Value. To learn more about this IBM Institute for Business Value study or the Center in Dublin, please email Susanne Dirks at susanne_dirks@ie.ibm.com. You can also browse a full catalog of IBM Institute for Business Value research at:

ibm.com/iibv

Authors

Susanne Dirks is the manager of the IBM Institute for Business Value Center for Economic Development Research. She is a senior managing consultant with a background in language translation, information technology and artificial intelligence, with over 13 years experience in IBM in several management and consulting roles. Prior to IBM, Susanne worked for a Siemens subsidiary and also spent some years working for herself. Susanne, who is also a certified translator (Universitaet Erlangen) for technology and economics, holds a First Class B.Sc. Honors Degree in Information Technology and Science, Technology and Society Studies and a Master of Science in Knowledge-Based Systems from Edinburgh University. Susanne can be reached at *susanne_dirks@ie.ibm. com*.

Dr. Mary Keeling is a managing consultant at the IBM Institute for Business Value Center for Economic Development. She joined IBM after over a decade of experience as an economist in the private sector and academia. Prior to IBM, she was a lecturer in economics at the University of Limerick. Before this, she lectured at Trinity College Dublin and also worked as an economist with Davy Stockbrokers. She has extensive experience in conducting research on productivity, structural change, trade specialization, economic development and the interdependence of financial markets. She graduated from NUI Maynooth in 1992 with a first class honors degree in Economics and Anthropology and also holds an M.A. in Economics and Finance from the same institution. She was awarded a Ph.D by Trinity College Dublin in 1998. Mary can be reached at *mary.keeling@ie.ibm.com*.

Contributors

Graham M. (Mark) Cleverley, Public Sector Director, Strategy, Global Government Business Solutions, IBM Sales & Distribution.

James W. Cortada, Public Sector Leader, IBM Institute for Business Value, IBM Global Business Services.

Ronan Lyons, formerly a managing consultant for the IBM Institute for Business Value Center for Economic Development.

Madli Kaju, Research Support, Institute for Business Value Center for Economic Development.

Gerard M. Mooney, Public Sector General Manager, Fiscal Stimulus and Economic Recovery, IBM Sales & Distribution.

The right partner for a changing world

At IBM, we collaborate with our clients, bringing together business insight, advanced research and technology to give them a distinct advantage in today's rapidly changing environment. Through our integrated approach to business design and execution, we help turn strategies into action. And with expertise in 17 industries and global capabilities that span 170 countries, we can help clients anticipate change and profit from new opportunities.

References

[1] Palmisano, Samuel J. "Shining Cities on a Smarter Planet." *The Huffington Post*. May 22, 2009. http://www.huffingtonpost.com/sam-palmisano/shining-cities-on-a-smart_b_206702.html

[2] Ibid.

[3] "World population prospects: The 2008 revision." Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. United Nations. Department of Economic and Social Affairs, Population Division. 2008.

[4] Ibid.

[5] IBM Center for Economic Development analysis, based on figures from the International Monetary Fund (IMF). "World Economic Outlook." April 2009. http://www.imf.org/external/pubs/ft/weo/2009/01/index.htm.

[6] OECD Stat Extracts. 2009. http://stats.oecd.org/WBOS/index.aspx.

[7] "European cities monitor 2008." Cushman & Wakefield. 2008.

[8] OECD, "Regions at a glance". OECD. 2005.

[9] "State of the world's cities 2008/2009: Harmonious cities," UN-HABITAT. 2008.

[10] For more details, see Owei, Vesper, Abiodun O. Bada and Manny Aniebonam. "Addressing the information technology skills shortage in developing countries: Tapping the pool of disabled users." *Journal of Information, Communication and Ethics in Society*. 2006; Lowell, B. Lindsay and Allan M. Findlay. "Skilled Labour Migration From Developing Countries: Analysis of Impact and Policy Issues." International Labour Organization (ILO). 2001.

[11] Orszag, P. "Health Costs Are the Real Deficit Threat." *The Wall Street Journal*,. May 15, 2009. http://online.wsj.com/article/SB124234365947221489.html; Skinner, Brett and Mark Rovere,. "Paying More, Getting Less 2007: Measuring the Sustainability of Government Health Spending in Canada." Fraser Institute. 2007. http://www.fraserinstitute.org/COMMERCE.WEB/product_files/PayingMoreGettingLess2007.pdf

[12] "Measuring administrative costs and reducing administrative burdens in the European Union." European Commission. 2006. http://ec.europa.eu/enterprise/regulation/better_regulation/docs/en_691.pdf

[13] Ibid.

[14] Johnson, Curtis W. and Neal R. Peirce. "Century of the city: No time to lose." The Rockefeller Foundation. 2008.

[15] Ibid.

[16] Ibid.

[17] Carisma, Brian and Sarah Lowder. "Economic costs of traffic congestion: A literature review for multiple locations." 2008. http://greenconsumerism.net/wp-content/uploads/2008/08/the-cost-of-traffic-congestion.pdf

[18] "State of the Internet: 4th quarter 2008." Akamai. 2008. http://www.akamai.com/stateoftheinternet/

[19] "KDDI to launch 1Gbps fiber-optic service in Oct." *Japan Today.* 2008. http://www.japantoday.com/category/technology/view/kddi-to-launch-1gbps-fiber-optic-service-in-oct

[20] "Urbanization and the Global Water Crisis". United States Agency for International Development . 2009. http://www.usaid.gov/our_work/environment/water/urbanization.html.

21 Kingdom, Bill, Roland Liemberger and Philippe Marin. "The challenge of reducing non-revenue water in developing countries. How the private sector can help: A look at performance-based service contracting." World Bank discussion paper No. 8." December 2006. http://www.ppiaf.org/documents/recent_publications/reducing_NRW_in_developing_countries.pdf

22 OECD. "Environmental Outlook to 2030." OECD. 2008

23 "The bubble is close to bursting: A forecast of the main economic and geopolitical water issues likely to arise in the world during the next two decades." World Economic Forum. January 2009. http://www.ppiaf.org/documents/recent_publications/Reducing_NRW_in_developing_countries.pdf

24 Ibid.

25 O'Brien, T. "Cities are running out of water, says expert." *The Irish Times*. April 16, 2009. http://www.irishtimes.com/newspaper/ireland/2009/0416/1224244810788.html

26 Burger, A. "Mayors' pledge to make 'drastic' CO_2 emissions cuts highlight of EU Sustainable Energy Week." International Institute for Sustainable Development. February 12, 2009. http://www.globalwarmingisreal.com/blog/2009/02/12/mayors-pledge-to-make-%E2%80%9Cdrastic%E2%80%9D-co2-emissions-cuts-highlight-of-eu-sustainable-energy-week/

27 "Lights out in 2009?" The NextGen Energy Council. September 2008. http://www.next-genenergy.org/Portals/NextGen/studies/Nextgen_Lights_Out_Study.pdf

28 "Global Anthropogenic GHG Emissions by Sector." Pew Center on Global Climate Change. 2004. http://www.pewclimate.org/facts-and-figures/international/by-sector

29 "The bubble is close to bursting: A forecast of the main economic and geopolitical water issues likely to arise in the world during the next two decades." World Economic Forum. January 2009. http://www.ppiaf.org/documents/recent_publications/Reducing_NRW_in_developing_countries.pdf

30 Ibid.

31 "Conversations for a Smarter Planet:14 in a series. Smarter water for a smarter planet." IBM. http://www.ibm.com/ibm/ideasfromibm/us/smartplanet/topics/water-management/20090316/index1.shtml

32 Palmisano, Samuel J. "A Smarter Planet: The Next Leadership Agenda." IBM. November 6, 2008. http://www.ibm.com/ibm/ideasfromibm/us/smartplanet/20081106/sjp_speech.shtml

33 Atkinson, Robert D., Daniel Castro and Stephen J. Ezell. "The Digital road to recovery: A stimulus plan to create jobs, boost productivity and revitalize America." International Technology and Innovation Foundation. 2009. http://www.itif.org/files/roadtorecovery.pdf

34 Rogers, Edwina. "The patient centered primary care collaborative. Major employers, consumers and physicians unite to revolutionize the healthcare system." The ERISA Industry Committee. 2007.

35 "Facts and results from the Stockholm trials." Stockholmsforsoket. 2006.

36 "DM adopts single window project for government services." AME Info. December 31, 2008. http://www.ameinfo.com/180001.html.

37 LaMonica, M. "GridWise trial finds 'smart grids' cut electricity bills." CNET. January 9, 2008. http://news.cnet.com/8301-11128_3-9847236-54.html.

38 For more about core competencies, please see: Dirks, Susanne, Mary Keeling and

Ronan Lyons. "Economic development in a Rubik's Cube World: How to turn global trends into local prosperity." IBM Institute for Business Value. January 2008. http://www-935.ibm.com/services/us/index.wss/ibvstudy/gbs/a1029246?cntxt=a1005266

[39] "Government 2020 and the perpetual collaboration mandate: Six worldwide drivers demand customized strategies." IBM Institute for Business Value. 2008. http://www-03.ibm.com/industries/government/us/detail/landing/G153005R79354P19.html?re=gihome67gov

[40] Headley Jubi and Kay Scrimger. "Lyon, France: Webb Opens First Transatlantic Summit of Mayors." US Conference of Mayors. 2000. http://usmayors.org/usmayornewspaper/documents/04_17_00/Lyon_front_pg.htm

IBM

GBE03227-USEN-00